Center Independent Research & Development: GSFC IRAD

A Multi-Spacecraft Multi-Objective Interplanetary Global Trajectory Optimization Transcription

Completed Technology Project (2017 - 2018)

Project Introduction

We propose to enhance GSFC's interplanetary mission design capability by designing a fully automated multi-spacecraft multi-objective interplanetary global trajectory optimization transcription. Advanced trajectory design technologies including the ability to design Distributed Spacecraft Missions (DSMs) are attracting increased interest but no mission design tool is currently capable of performing mission and systems design/optimization for an interplanetary DSM. This effort will deliver a software prototype capable of building the optimal design of a DSM-class mission where multiple spacecraft depart to the heliocentric regime from the same launch vehicle to perform coordinated science. This new capability will lay the groundwork for a follow-on proposal to implement this new capability into NASA Goddard's Evolutionary Mission Trajectory Generator (EMTG) where it will enable new announcements of opportunity for Distributed Spacecraft Missions.

Anticipated Benefits

Multi-spacecraft mission and systems optimization cannot currently be achieved using any current known mission design tools. Using current techniques, any multi-vehicle mission design and optimization is approximated with laborious iterative design of separate single-vehicle mission designs that require significant, expensive human-in-the-loop effort, and considers very little of the overall design space.

This effort will provide a robust software prototype that fully automates the mission and systems optimization of interplanetary multi-vehicle missions, which will both reduce the cost of the design process and dramatically improve the performance over any design found using traditional methods—providing GSFC a capability possessed by no other institution in the world. The result will bring new work to GSFC by providing highly competitive design solutions for any mission proposal involving ride-share and multiple spacecraft.

As an Early-Stage Innovation, the development of this capability will not only be tied to one mission, but rather enable an entirely new class of missions. The capability to rapidly design optimal multi-spacecraft missions will strengthen GSFC's foothold to lead more planetary science missions- making it a leader in the development of distributed spacecraft missions. Among other applications, this multi-spacecraft mission and systems optimization tool will provide new Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) class ride-share opportunities. We expect future funding to come from planetary science, heliophysics, and/or astrophysics mission studies using distributed spacecraft to demonstrate this technology over the next five years.

Innovative trajectory design techniques at Goddard are being applied to enable fully automated rapid Distributed Spacecraft Mission and Systems design. Image credit: NASA

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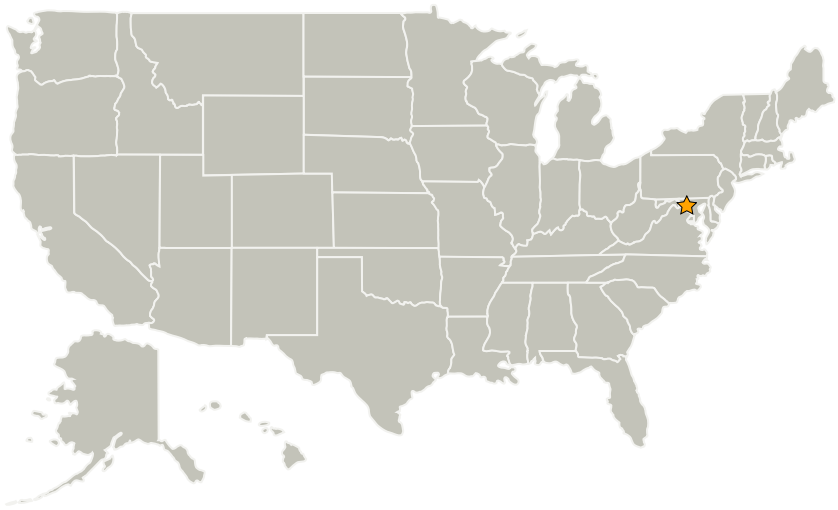
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

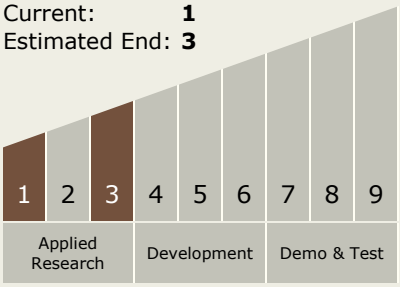
Jason W Mitchell
Timothy D Beach

Principal Investigator:

Sean W Napier

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



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Images

Innovative Trajectory Design Techniques for Distributed Spacecraft Mission Design
Innovative trajectory design techniques at Goddard are being applied to enable fully automated rapid Distributed Spacecraft Mission and Systems design. Image credit: NASA
(https://techport.nasa.gov/image/28314)

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.5 Mission Architecture, Systems Analysis and Concept Development
    - TX11.5.2 Tools and Methodologies for Performing Systems Analysis

Target Destinations

Others Inside the Solar System, Foundational Knowledge